PROC. ENTOMOL. SOC. WASH.
97(3), 1995, pp. 634–638

INTRAGUILD PREDATION BETWEEN SYMPATRIC SPECIES OF MANTIDS (MANTODEA: MANTIDAE)

MATTHEW D. MORAN

Ecology Program, Department of Biology, University of Delaware, Newark, Delaware 19716.

Abstract.—I tested the importance of predation versus competition in two congeneric sympatric species of mantids, *Tenodera aridifolia sinensis* (Saussure) and *T. angustipennis* (Saussure), during the late portion of the juvenile stage of their life cycle. *Tenodera angustipennis* abundance was reduced through predation by the larger *T. a. sinensis,* but no evidence of competition for resources was demonstrated for either species. *Tenodera a. sinensis* gained more body mass in the presence of *T. angustipennis* indicating that the benefit of consuming smaller predators may outweigh the cost of competing for resources.

Key Words: Intraguild predation, competition, *Tenodera,* Mantodea, Mantidae

Although the main factor limiting the abundance of predators is predicted to be food (Hairston et al. 1960), regulation of population size by food limitation has been difficult to demonstrate among many predatory arthropods (Riechert and Cady 1983, Polis and McCormick 1986, Wise 1981, 1993). Among generalist predators, intraguild predation seems to be a prevalent interaction and may be important in regulation of abundance (Polis et al. 1989).

In the northeastern United States three species of mantids co-occur: *Tenodera aridifolia sinensis, T. angustipennis,* and *Mantis religiosa* L. (Rathet and Hurd 1983). As generalist predators, they have the potential to compete for prey, but differences in their life history apparently alleviate this. *Tenodera angustipennis* and *M. religiosa* hatch later than *T. a. sinensis,* establishing a size difference that allows them to consume different prey items (Hurd 1988) *Mantis religiosa* is spatially separated from the two *Tenodera* congeners by occupying a lower height in the vegetation (Rathet and Hurd 1983). Although these characteristics can reduce competition for prey, size differences between the species are great enough to promote intraguild predation (Hurd 1988, Hurd and Eisenberg 1990a). Since *T. angustipennis* and *T. a. sinensis* occupy the same vegetational strata, this interaction may be important for these two species.

This experiment was designed to test whether competition for prey or intraguild predation is a more important factor during the late portion of the juvenile stage (6–7 stadia) for these species and how these interactions affect the potential growth of individuals.

MATERIALS AND METHODS

The study site was an old field on the Experimental Farm of the University of Delaware. It consisted of mixed grasses and forbs with *Poa* spp. and *Solidago* spp. being the most common plants. On 2 August, 12 enclosures each measuring 1 m^3 were placed in the field in a 6 × 2 array. Each enclosure consisted of a PVC frame which was covered by fine nylon mesh (Bioquip Products, Gardena, CA). The enclosures were quickly placed on the ground to prevent the escape of resident arthropods.

From 3 to 5 August, both species of mantids (all females) were collected from a nearby field. This field has had a large population of both species for several years (personal observation). Each captured mantid was weighed (nearest 0.01 g), individually marked with nail polish and randomly assigned to a treatment group. The treatment groups were as follows: 1) three *T. a. sinensis,* 2) three *T. angustipennis,* and 3) three *T. sinensis* and three *T. angustipennis.* Each treatment consisting of four replicates was intentionally interspersed within the enclosure array. The mantids were introduced into the enclosures on 5 August. Each day following, the enclosures were inspected, and any mantid that had molted was marked again.

On 16 August, all cages were sampled by a combination D-vac and hand search. All surviving mantids were weighed to the nearest 0.01 g, and all other arthropods were separated into their respective orders.

RESULTS

At no time did more than one mantid molt during one 24 hour period. Therefore, I was able to track every surviving individual and recorded both an initial and final weight for each. The weight of the mantids at the beginning of the experiment did not differ between treatments (*T. a. sinensis* $t_{22} = 0.41$; $P = 0.68$; *T. angustipennis* $t_{22} = 1.41$; $P = 0.17$) for either species. I therefore assume that any response seen at the end of the experiment was not the result of initial bias.

Survivorship of *T. a. sinensis* was not significantly different ($t_6 = 0.52$; $P = 0.62$) between the two treatments (Table 1) while *T. angustipennis* showed decreased survivorship in treatment 3. Since there was only one surviving *T. angustipennis* in one replicate for treatment 3, it was not possible to do a statistical comparison. However, all replicates in treatment 2 had either two or three surviving *T. angustipennis,* while three of the four replicates in treatment 3 had no survivors.

Table 1. Mean survivorship (± 1 SE) of both species of mantids in their respective treatments. Treatment 1 = *T. a. sinensis,* Treatment 2 = *T. angustipennis,* Treatment 3 = *T. a. sinensis* + *T. angustipennis.*

Species	Treatment 1	Treatment 2	Treatment 3
T. sinensis	2.25 (0.25)	–	2.00 (0.41)
T. angustipennis	–	2.25 (0.25)	0.25 (0.25)

The mean weight of individual *T. a. sinensis* was significantly greater in treatment 3 (1.70 g ± 0.12) than in treatment 1 (1.35 g ± 0.06) ($t_{15} = 2.61$; $p = 0.02$) (Fig. 1). An analysis of variance on arthropod abundance for the three treatments showed that there was no statistical significance between treatments for any order or for total abundance of arthropods (Table 2).

DISCUSSION

At the conclusion of the experiment, there were fewer surviving *T. angustipennis* in treatment 3, where *T. a. sinensis* was also present, compared to treatment 2, where *T. a. sinensis* was absent. The high mortality was most likely due to predation by *T. a. sinensis,* as there were no other arthropods large enough to capture *T. angustipennis,* and I observed several such predation events during my daily monitoring. However, the removal of *T. angustipennis* by *T. a. sinensis* did not occur immediately, as *T. angustipennis* were observed in all the treatment 3 replicates through the sixth day of the experiment. Therefore, mantid densities were elevated in treatment 3 for a large portion of the experiment.

The differences in final weight between treatment 1 and treatment 3 show *T. a. sinensis* accumulated more biomass in the presence of *T. angustipennis.* This indicates that the value of consuming *T. angustipennis* outweighed the potential cost of in-

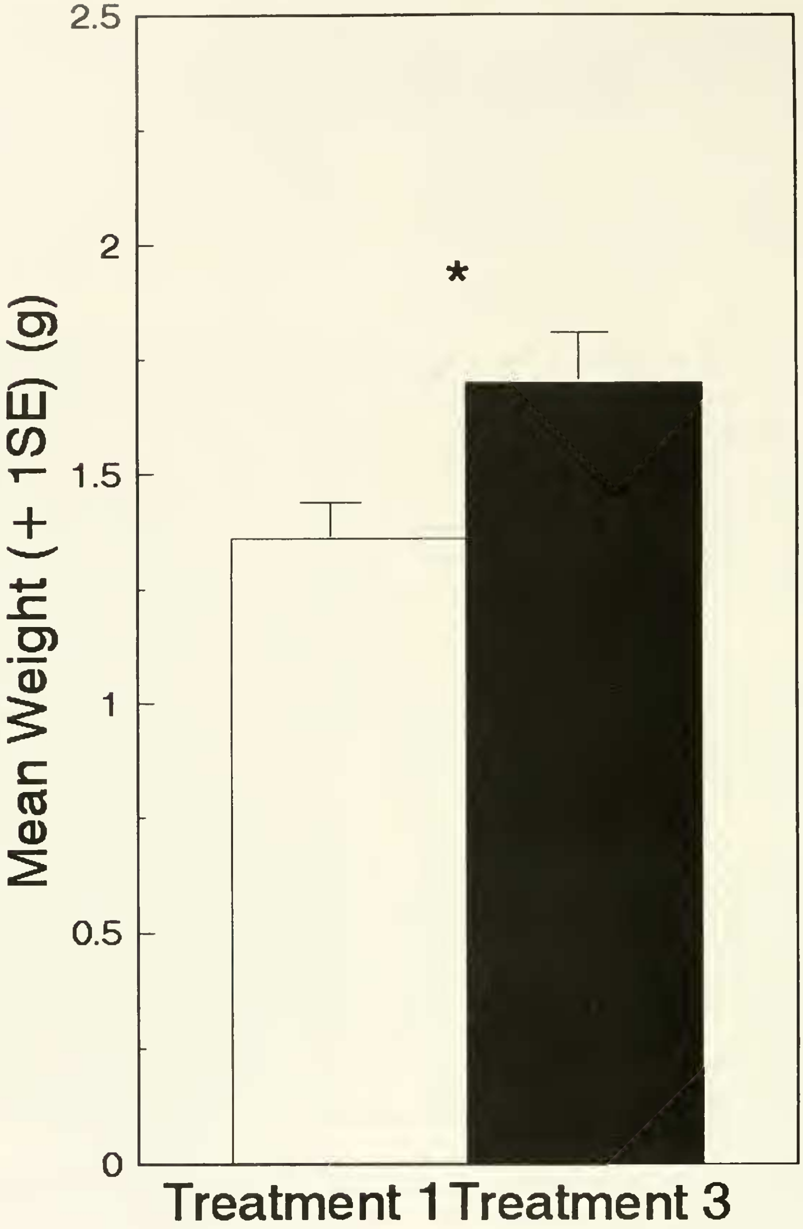

Fig. 1. Final mean weight (±1 SE) for *T. a. sinensis* in Treatment 1 (*T. a. sinensis* only) and Treatment 3 (*T. a. sinensis* and *T. angustipennis*). * $P < 0.05$.

creased competition for prey. The amount of biomass acquired during the juvenile stages of the life cycle affects the size a mantid will reach at adulthood. This determines the maximum weight gain possible which in turn affects the number of eggs oviposited (Eisenberg et al. 1981). Therefore, the *T. a. sinensis* individuals in the presence of *T. angustipennis* may have been able to produce more eggs.

Table 2. Arthropod abundance (± SE) and corresponding ANOVA analysis. Orders are arranged in descending abundance for Treatment 1 (T1). T1 = *T. a. sinensis*, T2 = *T. angustipennis*, T3 = *T. a. sinensis* + *T. angustipennis*.

Order	T1	T2	T3	$F_{2,9}$	*P*
Araneae	33.0 (8.2)	21.8 (6.5)	21.0 (5.4)	0.98	0.41
Homoptera	23.3 (4.3)	29.8 (4.9)	48.8 (10.5)	3.47	0.07
Hymenoptera	11.8 (3.8)	6.3 (1.3)	11.5 (2.3)	1.34	0.31
Diptera	7.0 (2.5)	4.8 (1.5)	5.8 (2.3)	0.27	0.77
Hemiptera	6.0 (3.3)	6.3 (3.3)	20.3 (10.4)	1.53	0.27
Thysanoptera	3.3 (2.9)	1.0 (0.0)	1.0 (1.0)	1.53	0.27
Coleoptera	0.5 (0.3)	1.3 (0.6)	2.8 (1.8)	1.06	0.39
Total	85.0 (10.9)	71.0 (8.0)	112.0 (27.8)	1.37	0.30

The analysis of the arthropod assemblage showed there was no difference between treatment groups in either total abundance or within any individual order. It would be expected that treatment 3 would have had lower abundance of arthropods, since the density of mantids was double the other treatments. Actually, the trend was for elevated arthropod density in treatment 3 although this was not significant. It has been shown in recent experiments that increasing the density of predators may have little impact on the prey density (Hurd and Eisenberg 1990b, Fagan and Hurd 1991, Wise 1993). This was a short-term experiment and significant depressions of prey in the presence of elevated predator densities may not have had time to occur. A previous experiment (Moran and Hurd 1994) indicated that important short term interactions during elevated predator densities were intraguild predation and emigration by predators small enough to be potential prey. Increased food limitation became a factor only later in the study.

This experiment showed that the major short term interaction between these two species was predation while competition was apparently absent. That *T. a. sinensis* demonstrated greater weight gain in the presence of *T. angustipennis* indicates that top level predators may benefit from other predators being present. The benefit of using other predators as prey may therefore outweigh the cost of interspecific competition within this guild, at least in the short-term.

ACKNOWLEDGMENTS

I am grateful to T. P. Rooney for assistance with the D-vac and L. E. Hurd for reading an earlier draft of the manuscript.

LITERATURE CITED

Eisenberg, R. M., L. E. Hurd, and J. A. Bartley. 1981. Ecological consequences of food limitation for adult mantids (*Tenodera sinensis Saussure*). American Midland Naturalist 106: 209–218.

Fagan, W. F. and L. E. Hurd. 1991. Direct and indirect effects of generalist predators on a terrestrial arthropod community. American Midland Naturalist 126: 380–384.

Hairston, N. G., F. E. Smith, and L. B. Slobodkin. 1960. Community structure, population control, and competition. American Naturalist 94: 421–425.

Hurd, L. E. 1988. Consequences of divergent egg phenology to predation and coexistence in two sympatric, congeneric mantids (Orthoptera: Mantidae). Oecologia 76: 549–552.

Hurd, L. E. and R. H. Eisenberg. 1990a. Arthropod community responses to manipulation of a bitrophic predator guild. Ecology 76: 2107–2114.

———. 1990b. Experimentally synchronized phenology and interspecific competition in mantids. American Midland Naturalist 124: 390–394.

Moran, M. D. and L. E. Hurd. 1994. Short-term responses to elevated predator densities: Noncompetitive intraguild interactions and behavior. Oecologia (In press.)

Polis, G. A. and S. J. McCormick. 1986. Scorpions, spiders, and solpugids: predation and competition among distantly related taxa. Oecologia 71: 111–116.

Polis, G. A., C. A. Myers, and R. D. Holt. 1989. The ecology and evolution of intraguild predation. Annual Review of Ecology and Systematics 20: 297–330.

Rathet, I. H. and L. E. Hurd. 1983. Ecological relationships of three co-occurring mantids, *Tenodera* *sinensis* (Saussure), *T. angustipennis* (Saussure), and *Mantis religiosa* (Linnaeus). American Midland Naturalist 110(2): 240–248.

Riechert, S. E. and A. B. Cady. 1983. Patterns of resource use and tests for competitive release in a spider community. Ecology 71: 1441–1450.

Wise, D. H. 1981. Inter- and intraspecific effects of density manipulations upon females of two orbweaving spiders (Araneae: Araneidae). Oecologia 48: 252–256.

Wise, D. H. 1993. Spiders in Ecological Webs. Cambridge University Press, Cambridge, Great Britain.